

Patent claims

1. Process for the recovery of a gaseous phase from a liquid fluid on a commercial scale by at least partial evaporation of the liquid fluid or of at least one of the components contained therein or by setting free one of the components formed by thermal transition of the liquid fluid in a modular falling-film evaporator consisting of stacked vertical or inclined plate-type modules, with at least every other module being constructed as an evaporator module, and gap-type evaporation chambers between mutually facing side surfaces of essentially equal-sized rectangular modules,
characterised in that a falling-film evaporator is used, the evaporator modules of which feature a set of parallel micro-channels at least on one side facing the gap-type evaporation chambers, the orientation of the micro-channels corresponding to the direction of the liquid fluid stream flowing therein by gravity and/or capillary forces and the evaporation chambers of which are open at the top and/or bottom essentially over the entire width of the module, the liquid fluid being fed to the micro-channels by a feeding device, the micro-channels being indirectly heated by a heat exchange fluid passing through the evaporator modules, and the gaseous phase formed being withdrawn from the evaporation chambers that are open at the top and/or bottom.
2. Process according to claim 1,
characterised in that a falling-film evaporator is used, the evaporator modules of which comprise two essentially equal-sized interconnected plates which enclose one or several spaces through which a heat exchange fluid is conveyed and which feature a set of micro-channels on a side facing the evaporation chamber.
3. Process according to claim 1 or 2,
characterised in that a falling-film evaporator is used, the width (s) of the gap-type evaporation chambers, as measured from the bottom of the micro-channels, ranging from the value greater than the depth (t) of the micro-channels and smaller than 20 mm, the width (b) of the micro-channels being less than 2000 μm , especially in the range from 50 μm to 500 μm , and the maximum depth (t) of the micro-channels being less than 1000 μm , especially in the range from 25 μm to 500 μm , the width of the webs between the micro-channels being less than 1000 μm , especially 25 μm to 500 μm .

4. Process according to any one of the preceding claims 1 to 3,
characterised in that a gas is fed to the gap-type evaporation chambers from lower or upper side, thus expelling from the falling-film evaporator the gaseous phase formed from the liquid fluid.
5. Process according to any one of the preceding claims 1 to 4,
characterised in that the gaseous phase formed is made to react in situ within the evaporation chambers with a gaseous reactant fed to the gap-type evaporation chambers in co-current or counter-current, with the flow direction of the liquid fluid in or without the presence of a catalytically active coating on at least part of one or both module surfaces delimiting the evaporation chamber.
6. Process according to any one of the preceding claims 1 to 5,
characterised in that a falling-film evaporator is used comprising either several stacks of vertically arranged modules and gap-type evaporation chambers located between them and/or at least one homologous stack which comprises several horizontally arranged zones, the gap-type chambers between the modules being open at the top and/or bottom over essentially the entire width of the modules, and that heat exchange fluids of different temperatures are conveyed through the modules of the individual stacks and/or through the individual zones of the modules as required.
7. Process according to claim 6,
characterised in that the liquid fluid in the form of a solution of a thermolabile compound is fed to heated micro-channels of the evaporator modules of a first stack or a first zone of a stack, the downward flowing liquid undergoing concentration and being fed to cooled micro-channels of modules of a second homologous stack or a second zone and the recovered gaseous phase being withdrawn from the evaporation chambers of the first stack or the first zone for further processing.
8. Device for implementing the process according to any one of claims 1 to 7 on a commercial scale, said device comprising a modular falling-film evaporator containing at least one stack of vertical or inclined plate-type modules, at least every other module being designed as an evaporator module in that it features one or several spaces, through which a heat exchange fluid can flow, and gap-shaped evaporation chambers between the side surfaces of essentially equal-sized rectangular modules, with the surfaces facing each other,

characterised in that the evaporator modules feature a set of parallel micro-channels on at least one side facing the gap-type evaporation chambers, the orientation of the micro-channels corresponding to the direction of the liquid fluid stream flowing therein by gravity and/or capillary forces, and a device for feeding a liquid fluid into the micro-channels, the gap-type evaporation chambers being open at the top and/or bottom essentially over the entire width of the module, and that at least one stack being arranged in a vessel equipped with a device for withdrawing a gas phase and a device for withdrawing a liquid phase.

9. Device according to claim 8,

characterised in that gap-type evaporation chambers are open at the top and bottom but closed at the sides and that a back-flow of a gaseous phase leaving the gap-type evaporation chambers at the top into the lower section of the gap-type evaporation chambers is prevented by a partitioning element arranged between the vessel wall and the stack.

10. Device according to any one of the preceding claims 7, 8 or 9,

characterised in that the evaporator modules comprise two or more horizontal zones, at least one zone featuring a set of parallel micro-channels and every zone being equipped with separate devices for feeding and withdrawing a heat exchange fluid.

11. Device according to any one of the preceding claims 8 to 10,

characterised in that at least two stacks are arranged axially or laterally off-set above each other in one or more communicating vessels, the evaporator modules of the lowermost stack featuring a set of parallel micro-channels on at least one side as well as a device for feeding a liquid fluid, and a device for feeding a gas into the gap-type chambers being arranged at the lower end of each stack.

12. Process according to claim 6,

characterised in that an aqueous hydrogen peroxide solution is fed to a first stack or a first zone of a device according to the invention, thus obtaining a vapour phase containing hydrogen peroxide, this vapour phase being fed with the aid of an inert gas or an olefin containing 2 to 4 C atoms to a second stack or the second zone of

a stack of temperature-controlled plate-type modules with interposed reaction chambers, the plates being optionally coated with a catalyst or a catalyst bed being present in the reaction chambers, where the vapour phase is converted to a corresponding olefin oxide in the presence of an olefin with 2 to 4 C atoms.